

IVS WG 6

Final report

Rüdiger Haas

September 2013

Introduction

The IVS Directing Board established on its meeting in March 2009 in Bordeaux a working group on Education and Training. This working group is IVS WG6 and its work was to be reviewed regularly by the IVS DB at its meeting. The general aim of IVS WG6 is to support education and training in the field of geodetic and astrometric VLBI, in order to hand over and maintain expertise in this field for the next generations.

The Terms of Reference (ToR) of IVS WG6 were:

to establish contacts to education institutions in geodesy, geosciences and astrometry worldwide with the aim to raise interest in geodetic and astrometric VLBI among students

to develop education material that can be distributed to education institutions

to seek funding and to develop a concept and prepare the organization of training in form of for example IVS summer schools for master and PhD students

The WG was chaired by Rüdiger Haas: other initial members were Oleg Titov, Hayo Hase, Bjørn Engen, Johannes Böhm, Dirk Behrend, and Alan Whitney. Further candidate members were to be asked later to support the group.

ToR-1

The task was to establish contacts to education institutions in geodesy, geosciences and astrometry worldwide with the aim to raise interest in geodetic and astrometric VLBI among students. For this purpose several experts were asked to take care of the different continents:

Continent

North America
South America
Europe
Asia
Australia and Oceania
Africa

Responsible team

Alan Whitney and Dirk Behrend
Hayo Hase and Alan Whitney
Rüdiger Haas and Johannes Böhm
Dirk Behrend and Oleg Titov
Oleg Titov and Bjørn Engen
Lucia Plank and Rüdiger Haas

The responsible teams collected information on educational institutes that provide student education in geodesy, geosciences and astrometry. Unfortunately is the distribution of such institutions not equal for all continents. For some of the continents only a few contact addresses could be collected so far. There is more work to be done to collect potential contacts. Below we give a list of so far collected contacts addresses.

a) NORTH AMERICA:

Canada

- York University, Earth and Space Science Engineering, Spiros Pagiatakis, spiros (at) yorku.ca
- University of Calgary, Department of Geomatics Engineering, Prof. Michael G. Sideris, sideris (at) ucalgary.ca

México

- Universidad Autonoma de México, Departamento de Geodesia y Cartografía, Ing. Bartolo Lara Andrade, larandraba (at) gmail.com
- Instituto Politécnico Nacional, Unidad Ticomán Ciencias de la Tierra (ESIA), Ing. Julio Morales de la Garza, jmoralesd (at) ipn.mx

USA

- University of Colorado, Prof. Kristine Larson, kristinem.larson (at) gmail.com
- University of Nevada, Prof. Jeff Blewitt, gblewitt (at) unr.edu
- Lamont-Doherty Earth Observatory, Prof. James Davis, jdavis (at) ldeo.columbia.edu
- Ohio State University, Prof. Michael Bevis, mbevis (at) osu.edu

b) SOUTH AMERICA:

Argentina

- Universidad Nacional de La Plata – UNLP, Carrera de Ingeniería en Agrimensura, Dr. Ing. Marcos Actis, depagrim (at) ing.unlp.edu.ar

- Universidad Nacional de La Plata – UNLP, Carrera de Geofísica, Decano Dr. Adrián Brunini, agrimen (at) fi.uba.ar
- Universidad Nacional de Buenos Aires – UNBA, Carrera de Ingeniería en Agrimensura, Dr. Ing. Carlos Rosito, agrimen (at) fi.uba.ar
- Universidad Nacional de Tucumán – UNT, Carrera de Ingeniería Geodésica y Geofísica, Decano Ing. Sergio José Pagani, Dr. José Luis Vacafior, jvacafior (at) herrera.unt.edu.ar
- Universidad Nacional de Córdoba – UNC, Carrera de Ingeniería en Agrimensura, Decano Hector Gabriel Tavella, Ing. Susana Talquenca, comunicaciones (at) efn.uncor.edu
- Universidad Santiago del Estero, Carrera de Ingeniería en Agrimensura, Decano Héctor Rúben Paz, info-fce (at) unse.edu.ar
- Universidad Nacional del Sur – UNS, Carrera de Ingeniería en Agrimensura, Decano Carlos Rossit, dtoing (at) criba.edu.ar
- Universidad Nacional de Catamarca – UNCA, Carrera de Ingeniería en Agrimensura, Rector Ing. Flavio Fama
- Universidad de Morón, Carrera de Ingeniería en Agrimensura, Rector Héctor Norberto Porto Lemma, ingenieria (at) unimoron.edu.ar
- Universidad Nacional Juan Maza, Carrera de Ingeniería en Agrimensura, Decano Vicente Gonzalo Cremades, gorelo (at) umaza.edu.ar
- Universidad Nacional del Litoral – UNL, Carrera de Ingeniería en Agrimensura, Decano Ing. Mario Schreider, fich (at) fich.unl.edu.ar
- Universidad Nacional del Nordeste – UNNE, Carrera de Ingeniería en Agrimensura, Decana Dra. Lidia Itatí Ferraro de Corona, estudios (at) exa.unne.edu.ar sae (at) exa.unne.edu.ar
- Universidad Nacional del Nordeste – UNNE, Carrera de Ingeniería Civil, Decano Dr. Jorge Victor Pilar, info (at) ing.unne.edu.ar
- Universidad Nacional de Rosario – UNR, Carrera de Ingeniería en Agrimensura, Decano Ing. Elect. Oscar Enrique Peire, secdec@fceia.unr.edu.ar many (at) fceia.unr.edu.ar

Brazil

- UNESP - Universidade Estadual Paulista Júlio de Mesquita Filho, Departamento de Cartografía, Dr. João Carlos Chaves, jchaves (at) fct.unesp.br
- USP - Universidade de São Paulo, Departamento de Engenharia de Transportes, Dr. Edvaldo Simões da Fonseca Junior, edvaldoj (at) usp.br
- UFRGS - Universidade Federal do Rio Grande do Sul, Departamento de Geodésia, Dra. Andrea Lopes Iescheck, andrea.iescheck (at) ufrgs.br
- UFPE - Universidade Federal de Pernambuco, Departamento de Engenharia Cartográfica, Dr. Carlos A. Pessoa M. Galdino, galdino (at) ufpe.br
- IME - Instituto Militar de Engenharia, Seção de Ensino de Engenharia Cartográfica, Dr. Leonardo Castro de Oliveira, se6_chefia (at) ime.eb.br
- UERJ - Universidade do Estado do Rio de Janeiro, Departamento de Engenharia Cartográfica, Dr. Amauri Ribeiro Destri, destri (at) uol.com.br
- INPE - Instituto Nacional de Pesquisas Espaciais, Serviço de Pós-Graduação, Jose Carlos Becceneri, becce@lac.inpe.br posgraduacao (at) pgrad.inpe.br
- ON – Observatório Nacional, Geofísica, Dr. Sergio Luiz Fontes, sergio (at) on.br
- UFPR - Universidade Federal do Paraná, Engenharia Cartográfica e de Agrimensura, Dr. Luís Augusto Koenig Veiga, kngveiga (at) ufpr.br

Chile

- ACAPOMIL – Academia Politécnica Militar, Jefatura de Estudios, Teniente Coronel Neira, geografia (at) acapomil.mil
- Universidad de Concepción, Ingeniería Geomática, Dr. Juan Carlos Báez Soto, jbaez (at)

udec.cl

- Universidad de Santiago de Chile, Ingeniería en Geomensura, Dr. Belfor Portal Valenzuela, belfor.portal (at) usach.cl
- Universidad Técnica Metropolitana, Escuela de Geomensura, Luis del Canto Harboe, geomensura (at) utem.cl
- Universidad de Antofagasta, Ingeniería en Geomensura, Luis Fernández San Martín, uovando (at) uantof.cl
- Universidad Bernardo O'Higgins, Ingeniería en Geomensura y Cartografía, Sr. Abel Fuentes, geomensura (at) ubo.cl
- Universidad de Talca, Geomática, Yony Ormazábal, yormazabal (at) utalca.cl
- INACAP Maipú, Ingeniería en Geomensura, Sr. René Martínez Muñoz, maipu (at) inacap.cl

Colombia

- Universidad Distrital Francisco José de Caldas, Ingeniería Catastral y Geodesia, Coordinador - Ingeniería Catastral y Geodesia, ingcatastral (at) udistrital.edu.co

Costa Rica

- Universidad Nacional, Escuela de Topografía Catastro y Geodesia, Steven Oreamuno Herra, soreamun (at) una.ac.cr

Ecuador

- Escuela Politecnica del Ejercito, Carrera de Ingeniería Geográfica y Medio Ambiente, Dr Alfonso Tierra, fleon (at) espe.edu.ec
- Instituto Geográfico Militar, Proceso de Geodesia, Capitan Nicolay Vaca, nicolay.vaca (at) mail.igm.gob.ec

Honduras

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Panamá

- Universidad Tecnológica de Panamá, Escuela de Geotecnia Ingeniería en Geomática, Chun Quan Huang Lin, chun.huang (at) utp.ac.pa

Venezuela

- Universidad de Zulia, Departamento de Geodesia Superior, Escuela de Ingeniería Geodésica, Prof. Dr.-Ing. Eugen Wildermann, Prof. Msc-Ing. Karina Acurero, ewildermann (at) fing.luz.edu.ve kacurero (at) fing.luz.edu.ve

c) EUROPE:

Albania

- Tirana University, Department of Geography, Prof. Dr. Pal Nikolli, palnikolli (at) yahoo.com

Andorra

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Austria

- TU Graz, Institute of Theoretical Geodesy and Satellite Geodesy, Prof. Dr. Torsten Mayer-Gürr: mayer-guerr (at) tugraz.at
- TU Wien, Institute of Geodesy and Geophysics, Prof. Dr. Johannes Böhm: johannes.boehm (at) tuwien.ac.at

Belarus

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Belgium

- Royal Observatory of Belgium, Prof. Veronique Dehant, v.dehant (at) oma.be

Bosnia and Herzegovina

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Bulgaria

- University of Architecture, Civil Engineering and Geodesy, Department of Geodesy, Prof. Georgi Mitrev, gmitrev_fgs (at) uacg.bg

Croatia

- University of Zagreb, Faculty of Geodesy, Institute of Geomatics, Prof. Zeljko Bacic, zbacic (at) geof.hr

Cyprus

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Czech Republic

- Research Institute of Geodesy Topography and Cartography, Department of Geodesy and Geodynamics, Prof. Dr. Jakub Kostecky, kakub.kostecky (at) pecny.cz
- Czech Technical University in Prague, Department of Advanced Geodesy, Prof. Dr. Ing. Leoš Mervart, k152 (at) fsv.cvut.cz
- Brno University of Technology, Institute of Geodesy, Prof. Otakar Svabensky, svabensky.o (at) fce.vutbr.cz
- VSB – Technical University of Ostrava, Faculty of Mining and Geology, Institute of Geoinformatics, Prof. Dr. Zdenek Divis, zdenek.divis (at) vsb.cz
- Charles University in Prague, Faculty of Mathematics and Physics, Department of Geophysics, Prof. Zdenek Martinec, zdenek (at) hervam.troja.mff.cuni.cz

Denmark

- Aalborg University (AAU), Kai Borre, borre (at) es.aau.dk
- Technical University of Denmark (DTU), Niels Andersen, na (at) space.dtu.dk
- Technical University of Denmark (DTU), Per Knudsen, pk (at) space.dtu.dk

Estonia

- University of Tartu,
- University of Tallinn, Artu Ellman, Harli Jurgensen

Finland

- Aalto University, Martin Vermeer, martin.vermeer (at) aalto.fi
- Finnish Geodetic Institute (FGI), Markku Poutanen, martin.poutanen (at) fgi.fi

France

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Georgia

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Germany

- Bonn University, PD Axel Nothnagel, nothnagel (at) uni-bonn.de
- TU München, Prof. Hugentobler, urs.hugentobler (at) bv.tum.de
- Karlsruhe Institute of Technology, Prof. Heck, bernhard.heck (at) kit.edu
- Stuttgart University, Prof. Nico Sneuw
- Leibniz University Hannover, Prof. Jürgen Müller, mueller (at) ife.uni-hannover.de

Greece

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Hungary

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Iceland

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Ireland

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Italy

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Kazakhstan

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Latvia

- University of Latvia, Prof. Janis Kaminski, janis.kaminski (at) gmail.com

Liechtenstein

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Lithuania

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Luxembourg

- University of Luxembourg, Prof. Olivier Francis, olivier.francis (at) uni.lu
- University of Luxembourg, Prof. Felix Norman Teferle, norman.teferle (at) uni.lu
- University of Luxembourg, Prof. Tonie van Dam, tonie.vandam (at) uni.lu

Republic of Macedonia

- State University of Tetova, Faculty of Natural Sciences and Mathematics, Prof. Dr. Bashkim Idrizi, bashkim.idrizi (at) unite.edu.mk

Malta

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Moldova

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Monaco

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Montenegro

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Netherlands

– Delft University of Technology, Prof. Ambrosius, b.a.c.ambrosius (at) tudelft.nl

Norway

– University Ås, Geomatics, Bjørn Rangvald Pettersson

– University Ås, Oddgeir Kristiansen

Poland

– Polish Academy of Sciences, Space Research Centre, Prof. Dr. Aleksander Brzezinski, alek (at) cbk.waw.pl

Portugal

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Romania

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Russia

– St.Petersburg University, St Petersburg, Prof. Veniamin Vityazev

San Marino

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Serbia

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Slovakia

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Slovenia

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Spain

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Sweden

– Royal Institute, Stockholm, Prof. Lars Sjöberg

– Högskolan i Gävle, Stieg-Göran Mårtensson

Switzerland

– ETH Zürich, Prof. Markus Rothacher,

– University Bern, Rolf Dach

Turkey

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Ukraine

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United Kingdom

- University of Nottingham, Prof. Terry Moore
- Newcastle University, Prof. Matt King, m.a.king (at) ncl.ac.uk

Vatican City

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d) ASIA:

Afghanistan

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Armenia

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Azerbaijan

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Bahrain

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Bangladesh

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Bhutan

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Brunei

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Burma (Myanmar)

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Cambodia

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China

- Wuhan University, Prof. Erhu Wei, ehwei (at) sgg.whu.edu.cn

Hong Kong

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India

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Indonesia

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Iran

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Iraq

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Israel

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Japan

– Sapporo University, Prof. Kosuke Heki,

Jordan

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Kazakhstan

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Korea, North

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Korea, South

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Kuwait

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Kyrgyzstan

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Laos

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Lebanon

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Malaysia

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Maldives

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Mongolia

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Myanmar

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Nepal

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Oman

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Pakistan

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Philippines

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Qatar

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Saudi Arabia

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Singapore

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Sri Lanka

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Syria

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Taiwan

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Tajikistan

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Thailand

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New Zealand

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Palau

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Papua New Guinea

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Samoa

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Solomon Islands

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Tonga

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Tuvalu

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Vanuatu

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Botswana

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Cameroon

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Central African Republic

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Comoros

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Congo-Brazzaville

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Congo-Kinshasa

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Cote d'Ivoire

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Djibouti

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Egypt

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Equatorial Guinea

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Eritrea

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Ethiopia

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Gabon

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Gambia

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Ghana

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Guinea

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Guinea Bissau

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Kenya

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Lesotho

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Liberia

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Madagascar

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Malawi

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Mali

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Mauritania

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Mauritius

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Morocco

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Mozambique

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Namibia

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Niger

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Nigeria

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Rwanda

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Senegal

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Seychelles

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Sierra Leone

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Somalia

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South Africa

– Hartebeesthoek Radio Astronomical Observatory, Prof. Ludwig Combrinck, ludwig (at) hartrao.ac.za

South Sudan

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Sudan

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Swaziland

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São Tomé and Príncipe

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Tanzania

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Togo

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Tunisia

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Uganda

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Western Sahara

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Zambia

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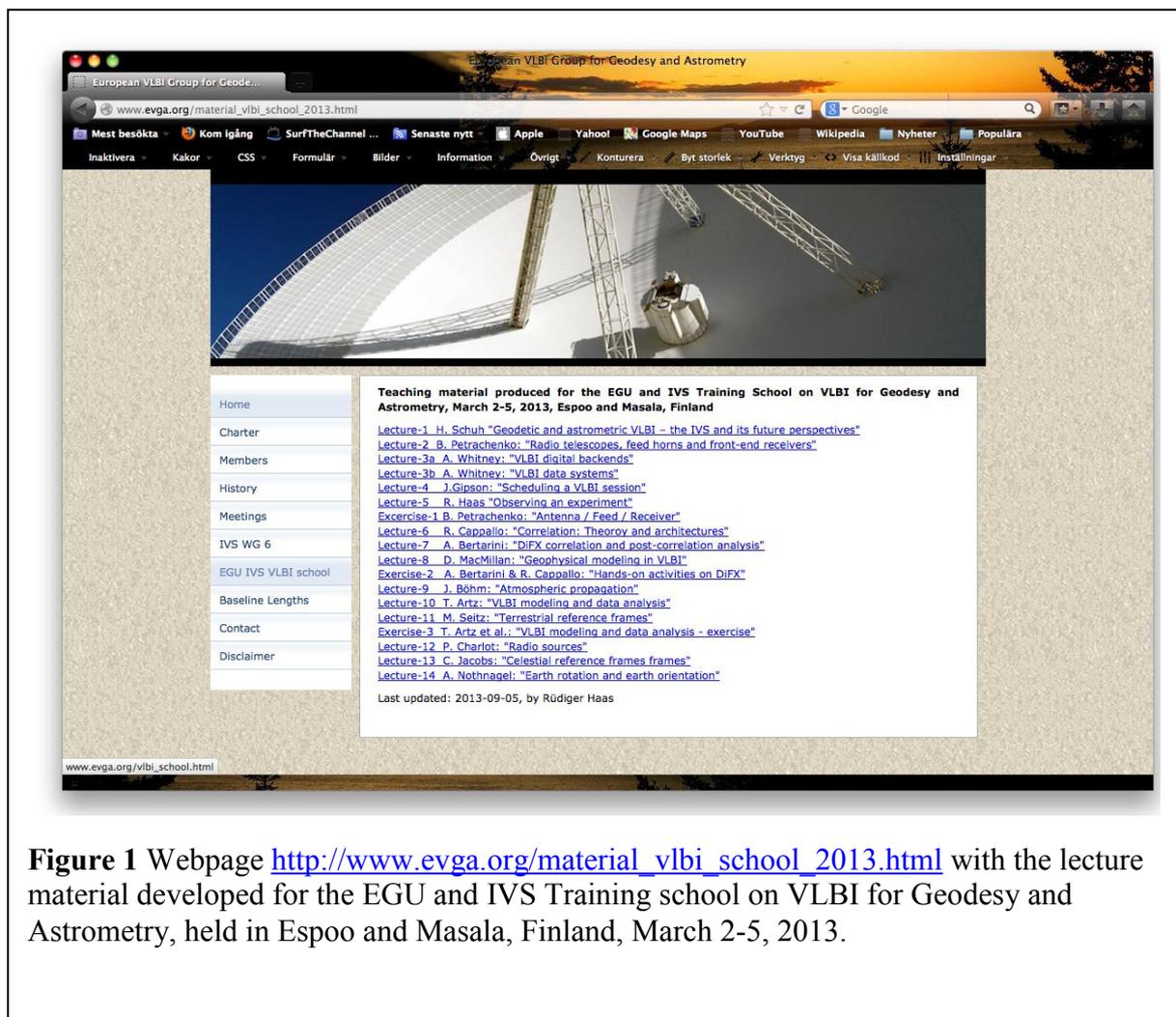
Zimbabwe

ToR-2

The task was to develop education material that can be distributed to education institutions.

The WG decided to start by collecting existing educational material. Material provided by Johannes Böhm and Harald Schuh from the Vienna Technical University, Austria, Chris Jacobs from the Jet Propulsion Laboratory, USA, and Rüdiger Haas from Chalmers University of Technology, Sweden. The material consists of pdf-files and is available at <http://www.evga.org/edumaterial.html>

As a next step, the plan was to collect and compile the material presented at the IVS VLBI school. This material consists of 14 lectures and 3 exercises and is available at http://www.evga.org/material_vlbi_school_2013.html , see Figure 1 below.



ToR-3

The task was to seek funding and to develop a concept and prepare the organization of training in form of for example IVS summer schools for master and PhD students.

Several attempts were done to apply for funding for a VLBI-school:

The first attempt was directed in the spring of 2011 towards NordForsk. NordForsk is an organisation under the Nordic Council of Ministers that provides funding for Nordic research cooperation as well as advice and input on Nordic research policy. We sent in an application to NordForsk's call for "Research Training Courses 2011" and applied for about 230 kNOK funding of a VLBI-school that was planned for the summer of 2011. For this call, NordForsk received in total 52 applications, out of which 20 were funded. Unfortunately, our application did not get any support.

The second attempt was an application to the "Training of Radio Astronomers" program of RadioNet. RadioNet is a project supported by the European Commission under the 7th Framework Programme (FP7). A support by RadioNet on the order of up to 2 k€ was granted for the organisation of a VLBI-school.

The third attempt was an application to the European Geosciences Union (EGU) in the fall of 2011. We submitted a proposal for a VLBI-school to the "Topical Meetings and Training Schools for 2012" program of the EGU outreach committee. We applied for a total budget of 23.5 k€ to organise a VLBI-school in the late summer of 2012 at Onsala. In November 2011 the EGU informed us that they would support the VLBI-school by 5 k€.

Since we so far had only 7k€ support from RadioNet and EGU, we decided to organise the VLBI-school not as a stand-alone occasion, but in connection to another VLBI-related meeting. We anticipated that this would make it easier for teachers and students to participate. We chose the EVGA meeting in March 2013 in Finland and EGU agreed to move the VLBI-school to 2013. We also discussed further support for the VLBI-school with the Aalto University in Espoo, the Finnish Geodetic Institute in Masala, and the Onsala Space Observatory. These three institutions granted additional support in terms of access to lecture halls, bus transport, coffee breaks, lunches, and a school dinner. The logos of the sponsors of the VLBI-school are presented in Figure 2. IVS supported the VLBI-school though teachers that are members of IVS. A report on the VLBI-school is given on the following pages.



Figure 2 The logos of the sponsors of the EGU and IVS Training School on VLBI for Geodesy and Astrometry, held in March 2013 in Finland.

Report on the

EGU and IVS Training School on VLBI for Geodesy and Astrometry

**Held 2013, March 2-5, at Aalto University, Espoo (Finland) and the
Finnish Geodetic Institute, Masala (Finland)**

Rüdiger Haas, Markku Poutanen, Minttu Uunila, 2013-04-22

A) GENERAL INFORMATION

The “EGU and IVS Training School on VLBI for Geodesy and Astrometry” was held March 2-5, 2013, in Finland. It was organized by Rüdiger Haas, head of IVS Working Group 6 on VLBI Education, in collaboration with Markku Poutanen, head of the geodesy division at the Finnish Geodetic Institute (FGI), and Minttu Uunila from Aalto University, Metsähovi Radio Observatory, Finland. The main goal of the VLBI school was to educate and provide training for the next generation VLBI researchers that will work with the next generation VLBI system for Geodesy and Astrometry. For that purpose, four days of lectures and exercises were arranged, with the intention to cover the VLBI system for Geodesy and Astrometry as complete as possible.

The lectures covered technical aspects, scheduling and observations, details of the correlation process, modeling and data analysis, and interpretation of the results. There were in total 14 lectures and 3 hands-on exercises. Some impressions on the activities during the VLBI-school are shown in Figures 3-6. The final session of the VLBI-school was held together with the 14th IVS Analysis Workshop.

The teachers that were giving lectures at the VLBI school are international experts in their fields and come from several research institutions worldwide:

- Thomas Artz (University of Bonn, Germany)
- Alessandra Bertarini (Max Planck Institute for Radioastronomy, Germany)
- Johannes Böhm (Vienna Technical University, Austria)
- Roger Cappallo (MIT Haystack Observatory, USA)
- Patrick Charlot (Bordeaux Observatory, France)
- John Gipson (NASA, NVI Inc., USA)
- Rüdiger Haas (Chalmers University of Technology, Sweden)
- Chris Jacobs (JPL, NASA, USA)
- Dan MacMillan (NASA, NVI Inc., USA)
- Axel Nothnagel (University of Bonn, Germany)
- Bill Petrachenko (National Resources Canada, Canada)
- Harald Schuh (GeoForschungsZentrum Potsdam, Germany)
- Manuela Seitz (DGFI, Germany)
- Alan Whitney (MIT Haystack Observatory, USA)

There were more than 60 applications for participation in the VLBI school, from interested students worldwide, including all continents. Finally, more than 50 students really could attend the VLBI-school, see the list of participants in Section 3. More than 50 % of the participants are active in educational programs on master's or PhD level, while the rest were more senior researchers. More than 35 % of the participants were female. The lecture slides are available via the webpages of the European VLBI Group for Geodesy and Astrometry (EVGA, www.evga.org/material_vlbi_school_2013.html).

The VLBI-school received some financial support from the European Geosciences Union (EGU) that was entirely used to support parts of the travel expenses of the master's and PhD students. The Onsala Space Observatory provided support for food in terms of coffee breaks and lunches during the VLBI-school. Aalto University provided the lecture room on Saturday, Monday and Tuesday, while the Finnish Geodetic Institute provided the lecture room on Sunday and some food. A small number of master's and PhD students sent in claims to RadioNet3 and were refunded for additional travel expenses.



Figure 3: Students listening to a lecture during the VLBI-school in the lecture hall at Aalto University, Espoo.



Figure 4: Alessandra Bertarini giving a lecture for the VLBI-school at the Finnish Geodetic Institute, Masala.



Figure 5: Roger Cappallo (right) advising a student group during Exercise-2 on software correlation.



Figure 6: Axel Nothnagel (left) supervising a student group during Exercise-3 on data analysis.

B) THE PROGRAM OF THE TRAINING SCHOOL

Day-1 (Saturday, 2013-03-02, @ Aalto University, Espoo)

09:00-09:15 Welcome and practical information (R. Haas, M. Poutanen)
09:15-10:00 "General overview on geodetic and astrometric VLBI and the IVS" (H. Schuh)
10:00-10:30 --- coffee break ---
10:30-12:00 "Radio telescopes, feed horns and receivers" (B. Petrachenko)
12:00-13:00 --- lunch break ---
13:00-14:30 "Digital backends and data acquisition" (A. Whitney)
14:30-15:00 --- coffee break ---
15:00-16:30 "Experiment scheduling" (J. Gipson)
16:30-17:15 "Observing an experiment" (R. Haas)
17:15-18:00 Exercise-1 (theoretical calculations, B. Petrachenko)

Day-2 (Sunday, 2013-03-03, @ FGI, Masala)

08:30-09:00 bus leaves from Helsinki downtown to Radisson blu Otaniemi Espoo
09:00-09:30 bus leaves from Radiosson blu Otaniemi Espoo to FGI Masala
09:30-11:00 "Correlator Architectures and VLB2010" (R. Cappallo)
11:00-11:30 --- coffee break ---
11:30-13:00 "Correlation preparation and post-correlation analysis" (A. Bertarini)
13:00-14:00 --- lunch break ---
14:00-15:30 "Geophysical models" (D. MacMillan)
15:30-16:00 --- coffee break ---
16:00-17:30 Exercise-2 (software correlation) (A. Bertarini & R. Cappallo)
17:30-20:00 "VLBI-school dinner"
20:00-21:00 bus transport back to Radiosson blu Otaniemi Espoo & Helsinki downtown

Day-3 (Monday, 2013-03-04, @ Aalto University, Espoo)

09:00-10:30 "Atmospheric propagation" (J. Böhm)
10:30-11:00 --- coffee break ---
11:00-12:30 "Data modeling and analysis" (Th. Artz)
12:30-13:30 --- lunch break ---
13:30-15:00 "Terrestrial reference frame" (R. Haas on behalf of M. Seitz)
15:00-15:30 --- coffee break ---
15:30-17:00 Exercise-3 (data analysis) (Th. Artz et al.)

Day-4 (Tuesday, 2013-03-05, @ Aalto University, Espoo)

09:00-10:30 "Radio sources" (P. Charlot)
10:30-11:00 --- coffee break ---
11:00-12:30 "Celestial Reference Frames" (Ch. Jacobs)
12:30-13:30 --- lunch break ---
13:30-15:00 "Earth rotation and orientation" (A. Nothnagel)
15:00-15:30 --- coffee break ---

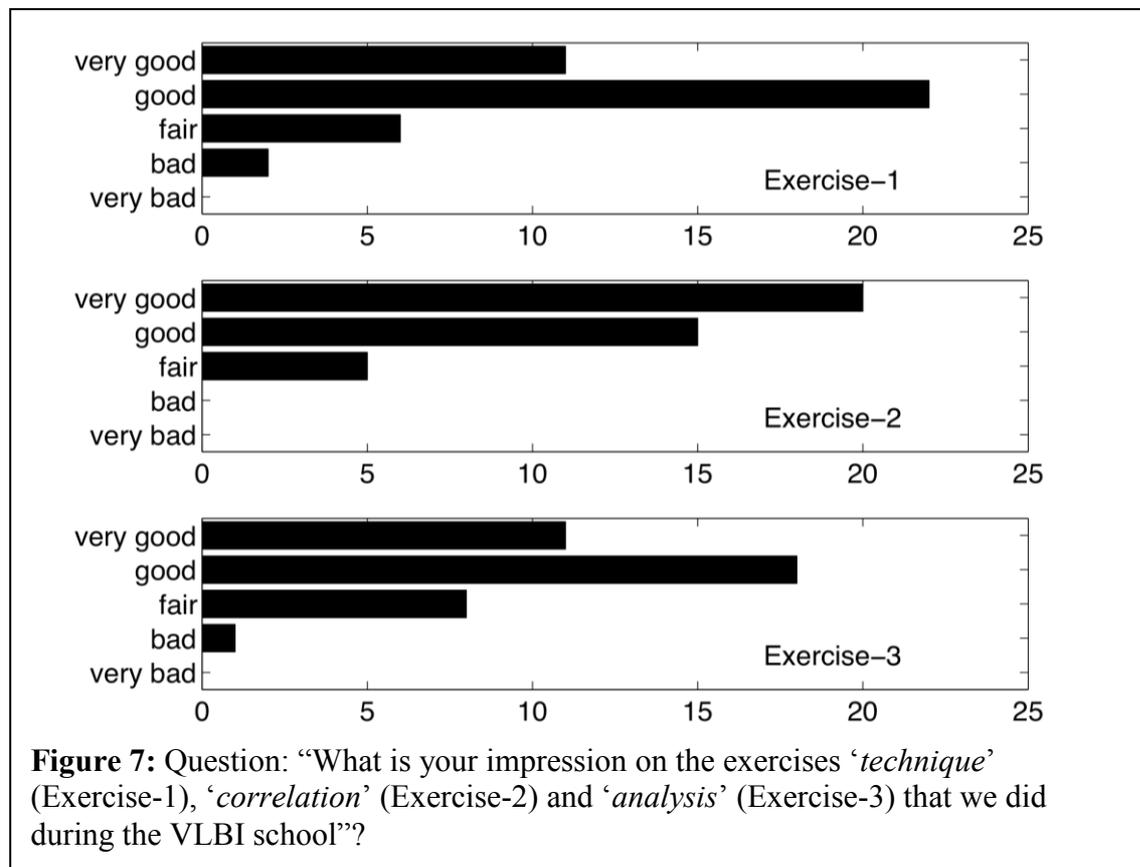
15:30-18:00 14th IVS Analysis Workshop (A. Nothnagel et al.)

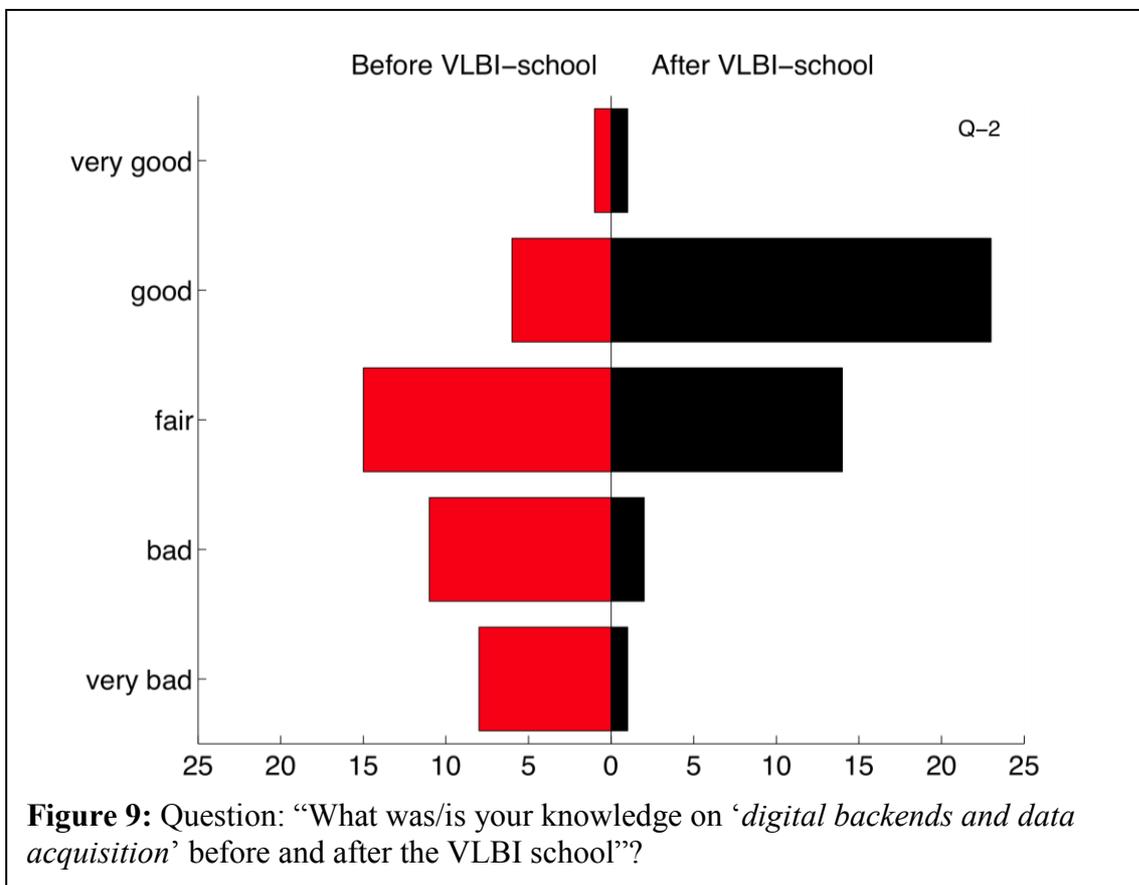
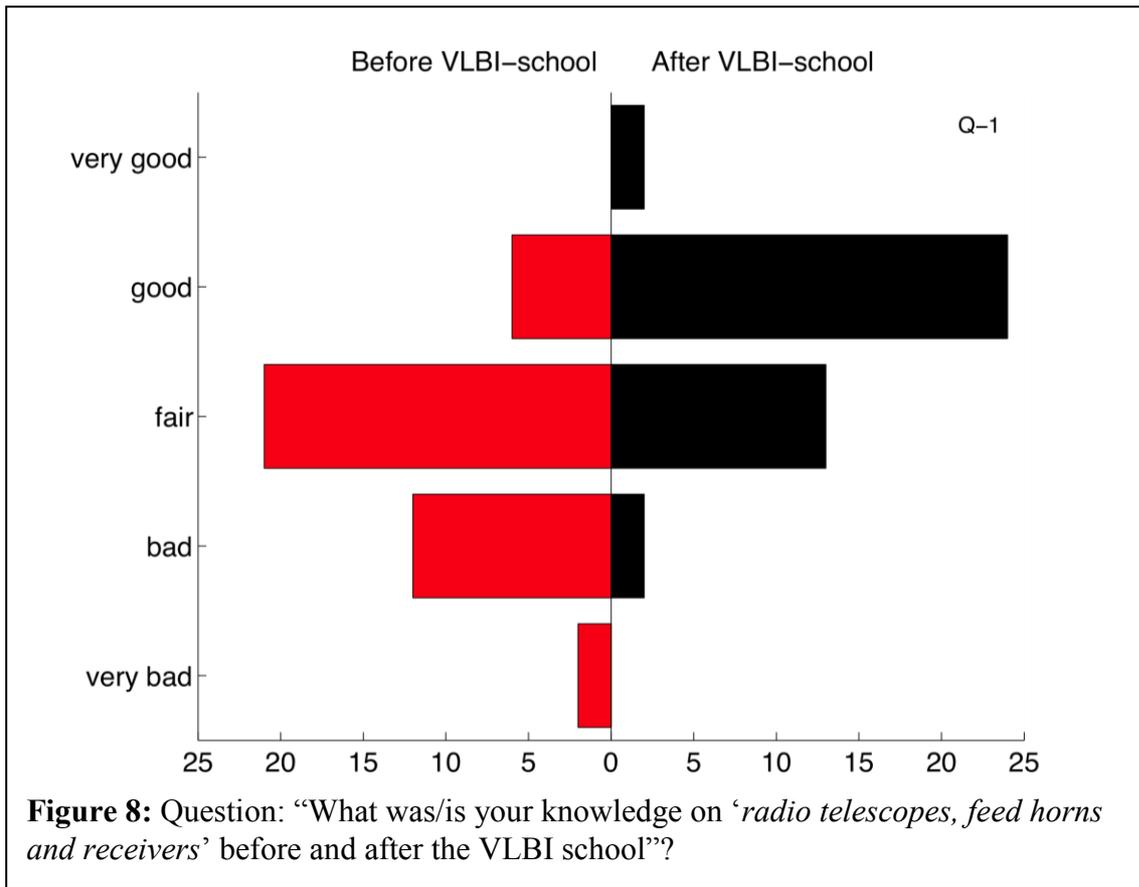
C) DISCUSSION AND EVALUATION OF THE TRAINING SCHOOL

The event was a Training School on VLBI for Geodesy and Astrometry with in total 14 lectures and 3 exercises. All lectures were 90 minutes long, except one that was only 45 minutes long. The exercises were between 45 and 90 minute long, and very much appreciated by the students. The first exercise covered purely technical aspects and focused on aspects like the calculation of sensitivity of radio astronomical systems. The students worked individually and had to solve several small tasks. The second exercise was on software correlation. The students worked in small groups of 4-5 persons and used the DiFX software correlator and the Haystack fringe-fitting software to derive VLBI group delay observables for the baseline Wettzell-Onsala of a real experiment. The third exercise then concentrated on the analysis of geodetic VLBI data. The students worked again in small groups of 4-5 people and performed the necessary ambiguity resolution and ionospheric corrections, and the final parameter estimation.

There was plenty of opportunity for the students to ask questions after the lectures, and there were lively discussions in the coffee breaks and lunch breaks. The students had access to all teachers and could ask questions and discuss various topics.

At the end of the last day an evaluation questionnaire was handed out to the students and they were asked to evaluate the VLBI Training School. Copies of the original answers can be provided on request. A summary of the results of the evaluation is presented below.





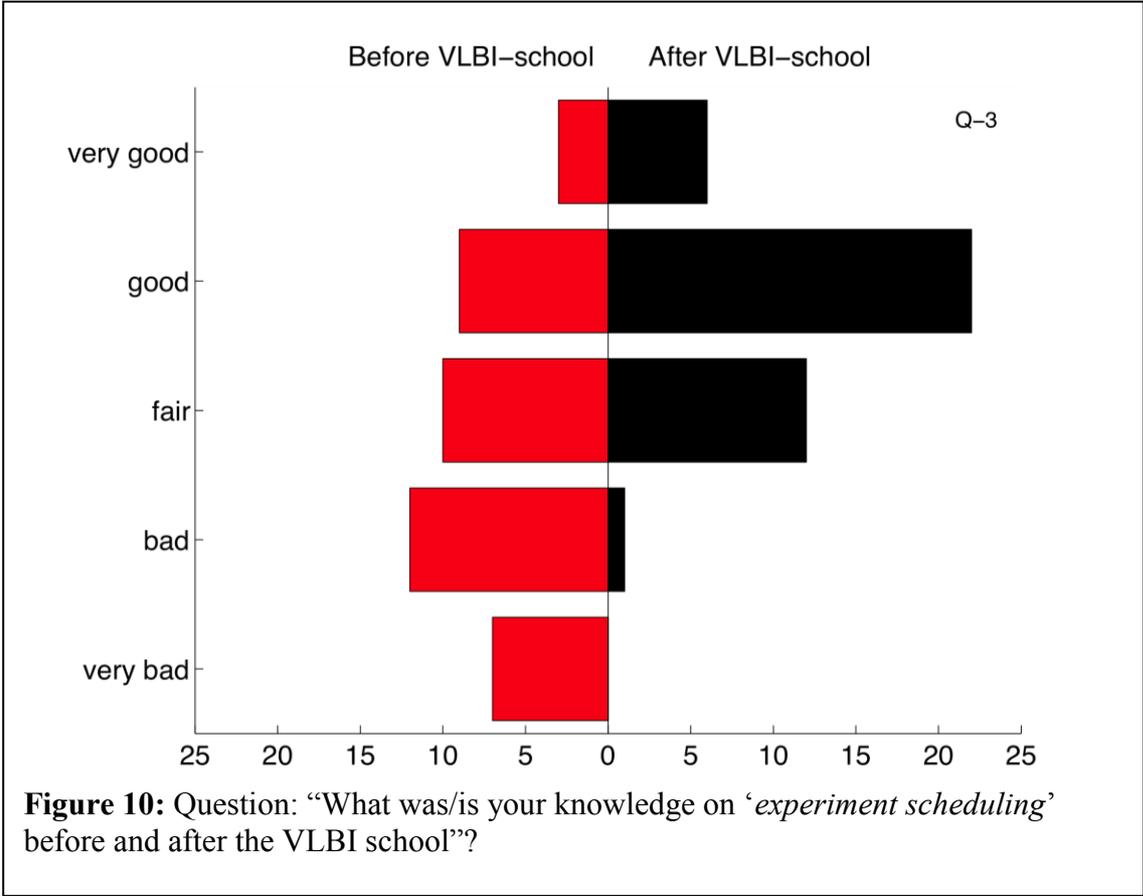


Figure 10: Question: “What was/is your knowledge on ‘*experiment scheduling*’ before and after the VLBI school?”

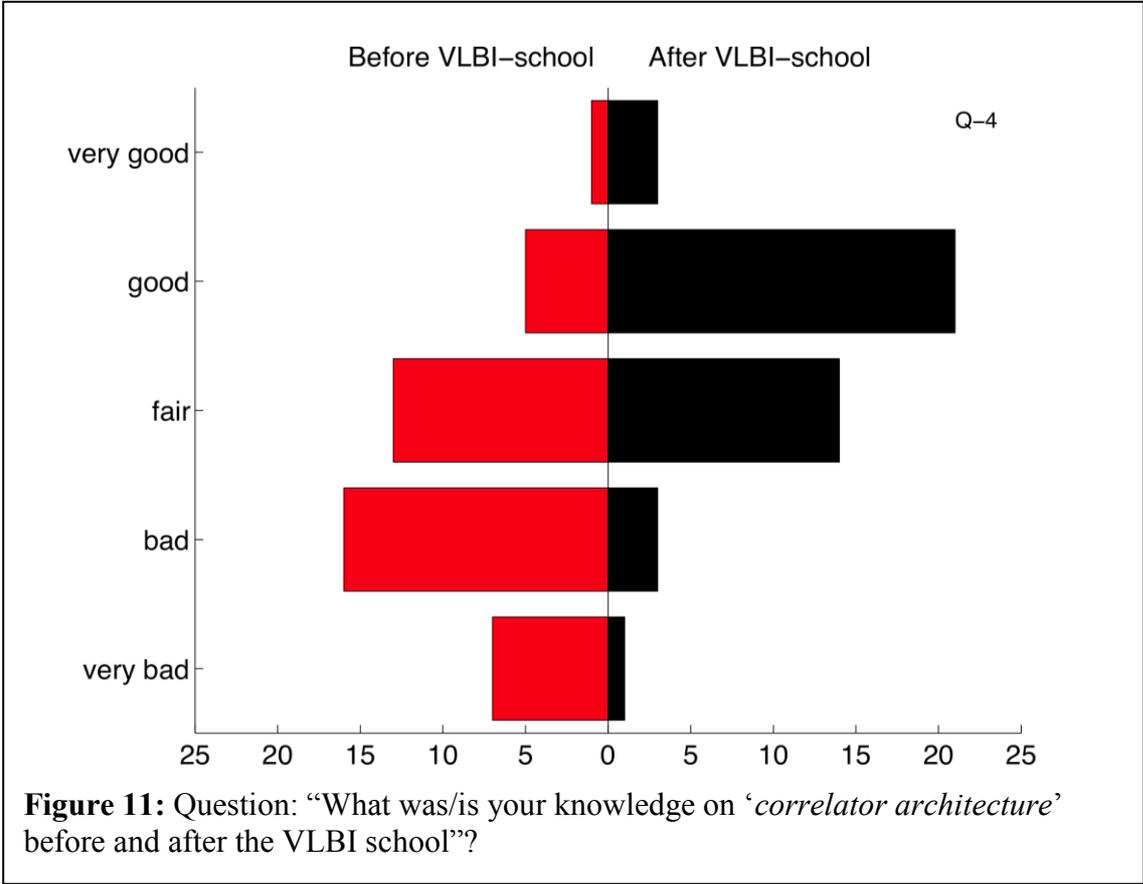
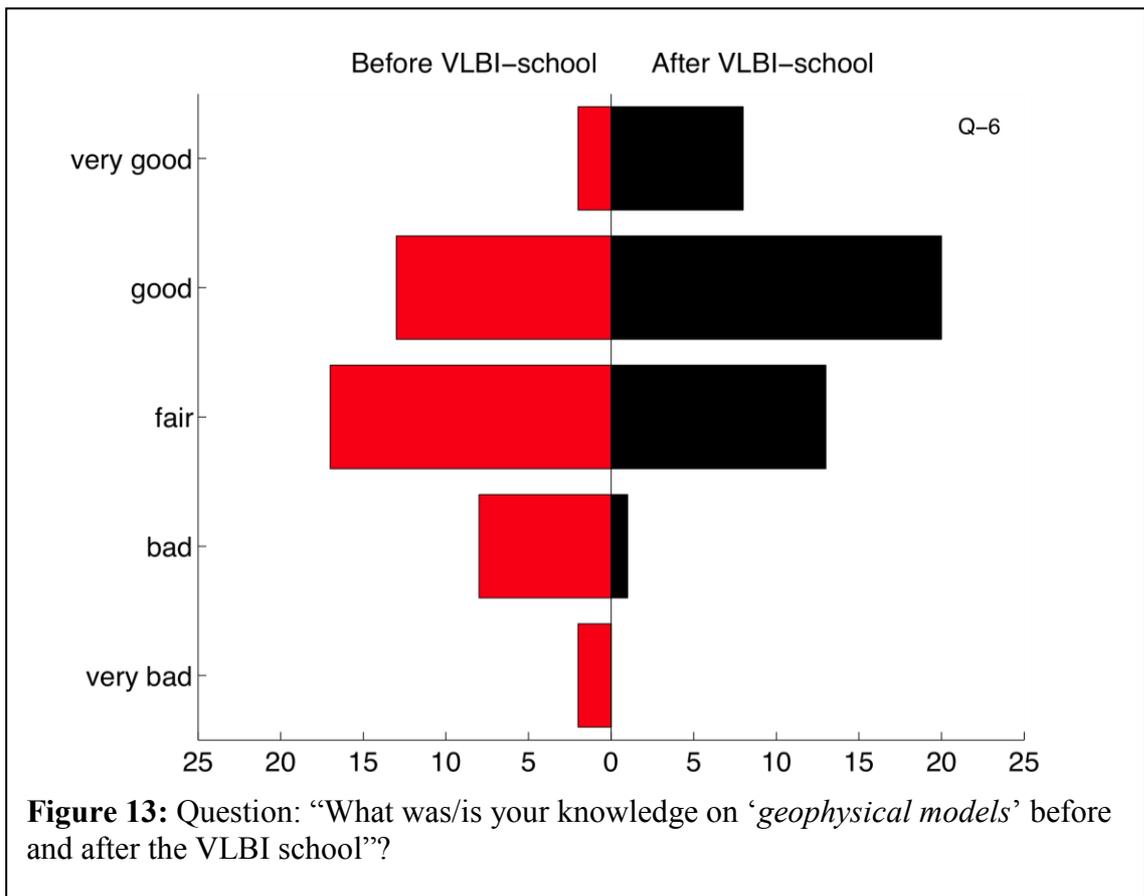
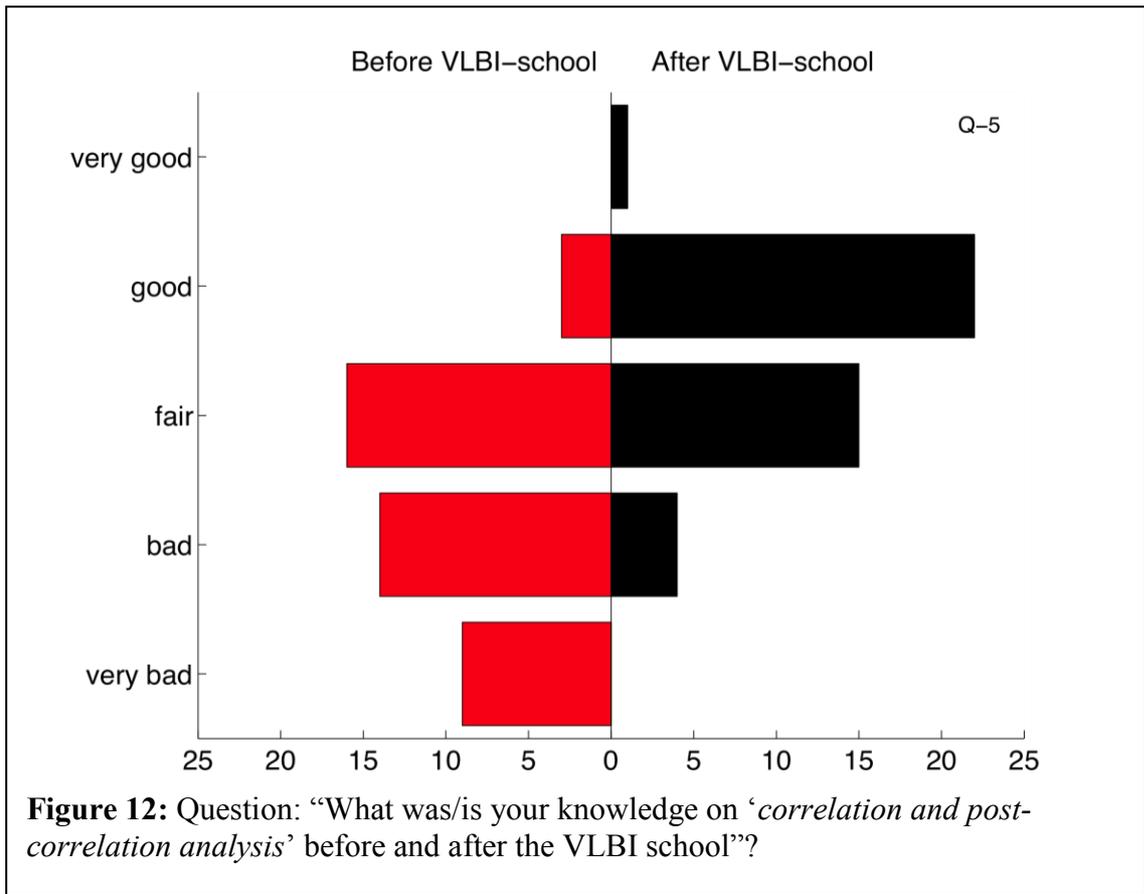
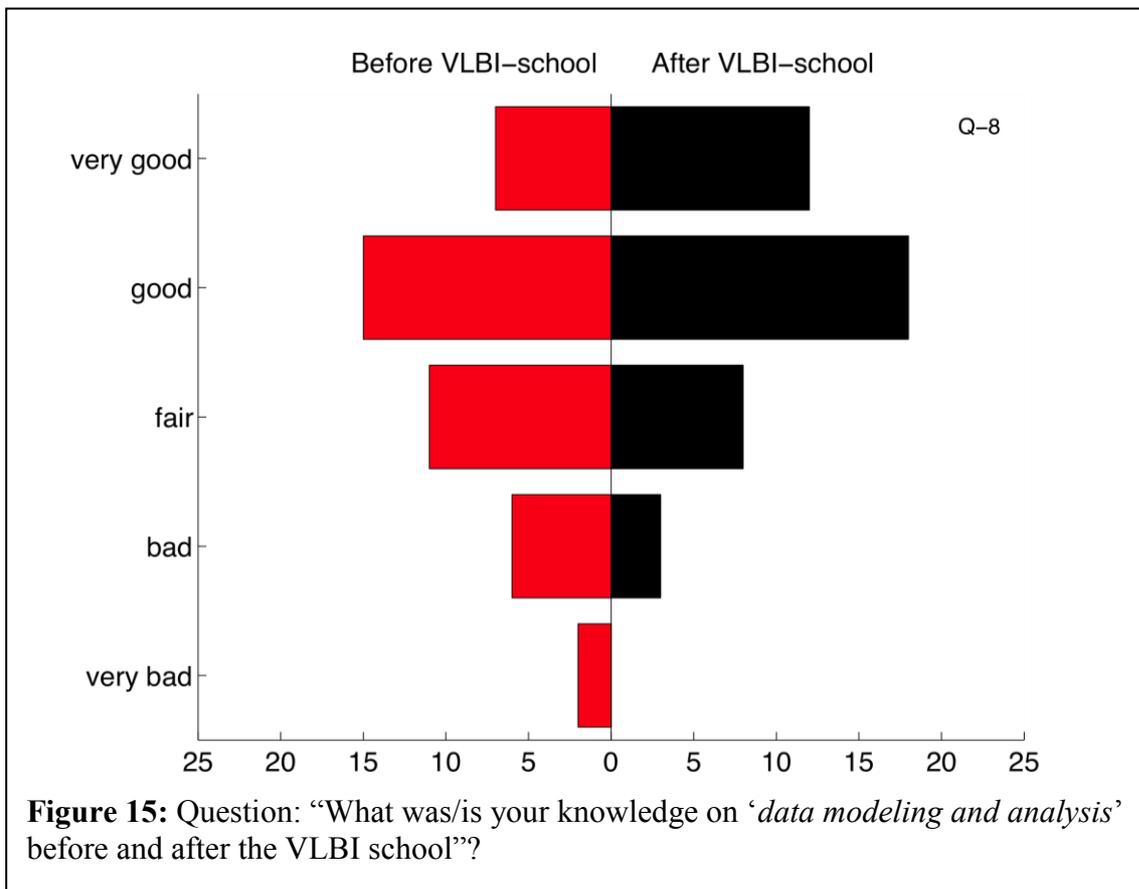
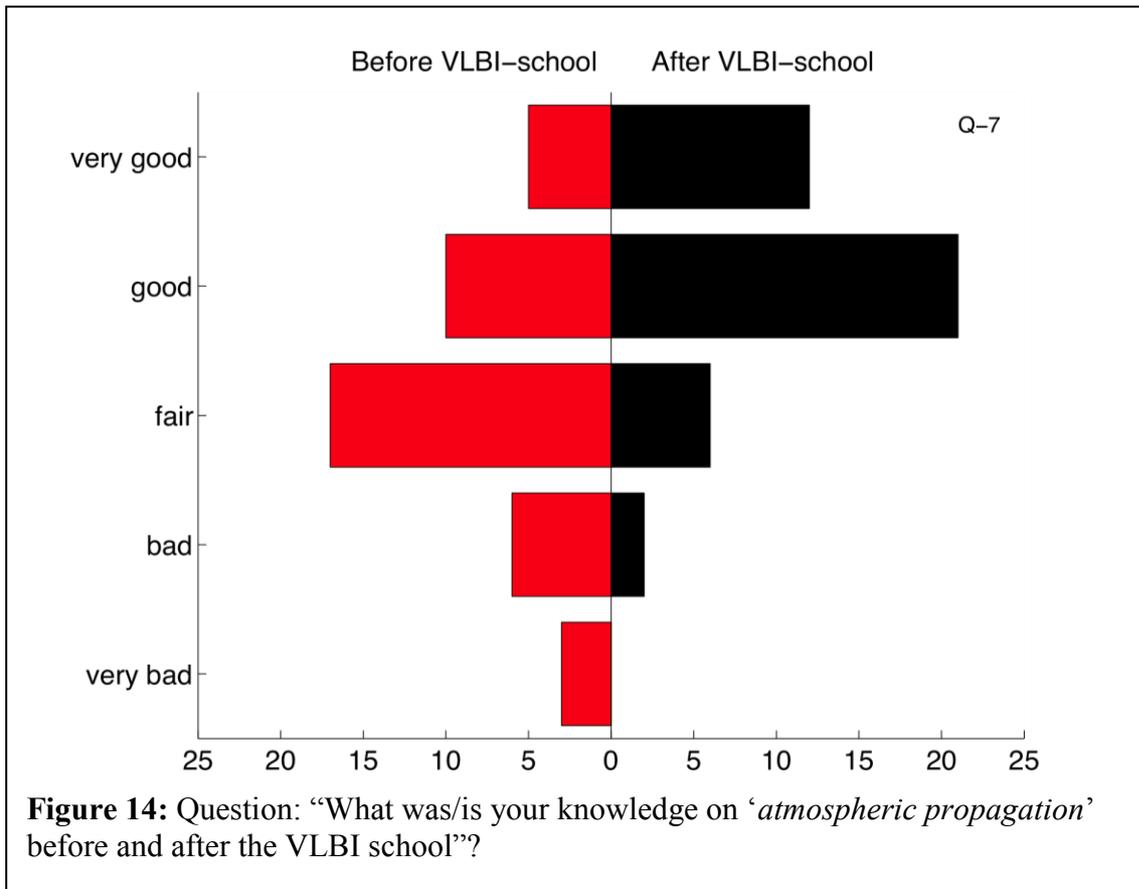


Figure 11: Question: “What was/is your knowledge on ‘*correlator architecture*’ before and after the VLBI school?”





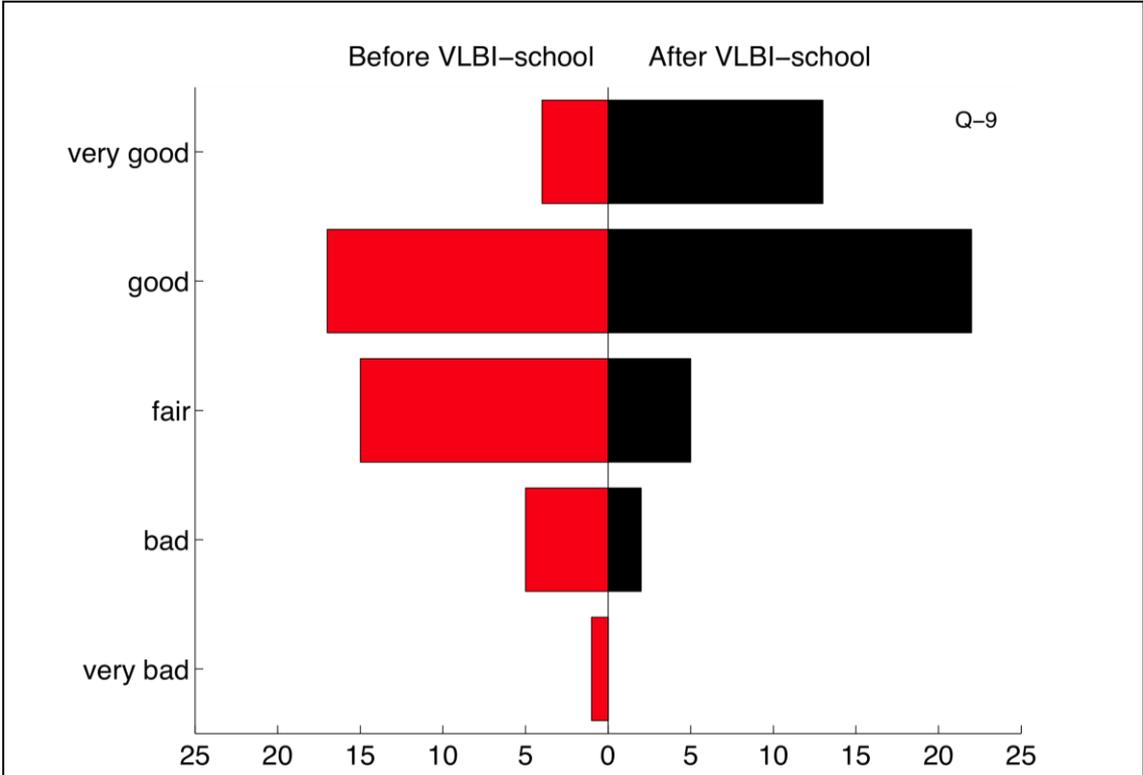


Figure 16: Question: “What was/is your knowledge on ‘*terrestrial reference frames*’ before and after the VLBI school?”

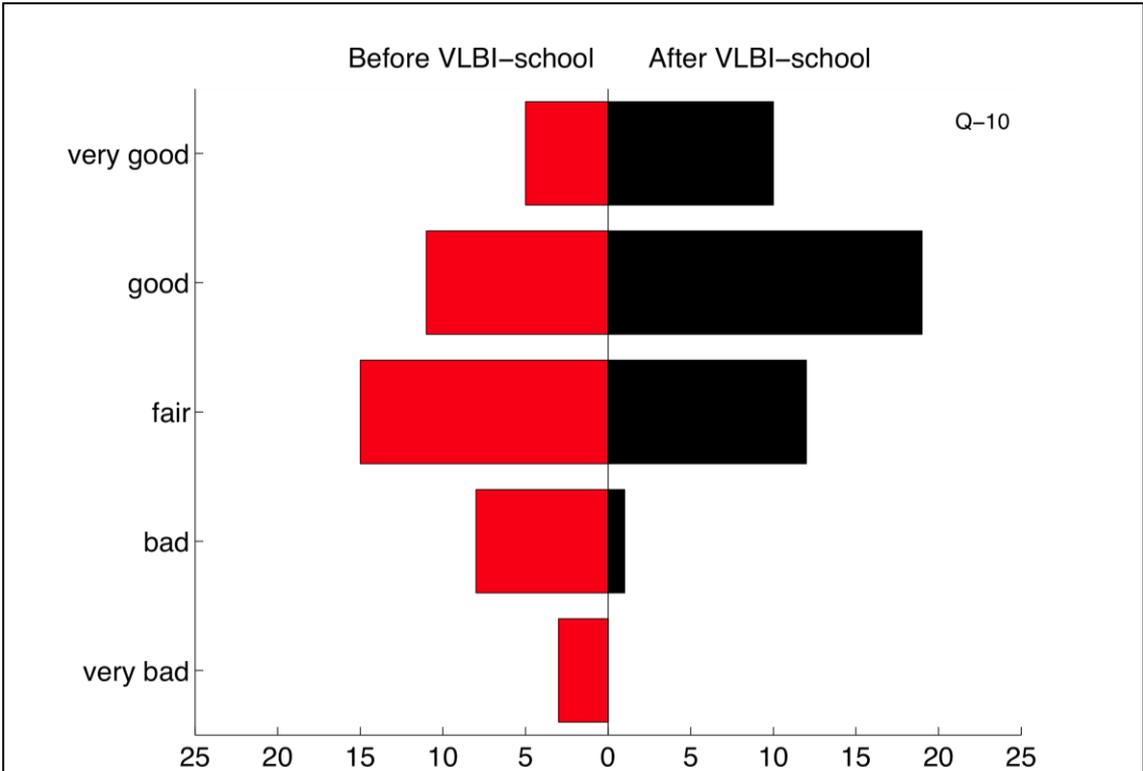
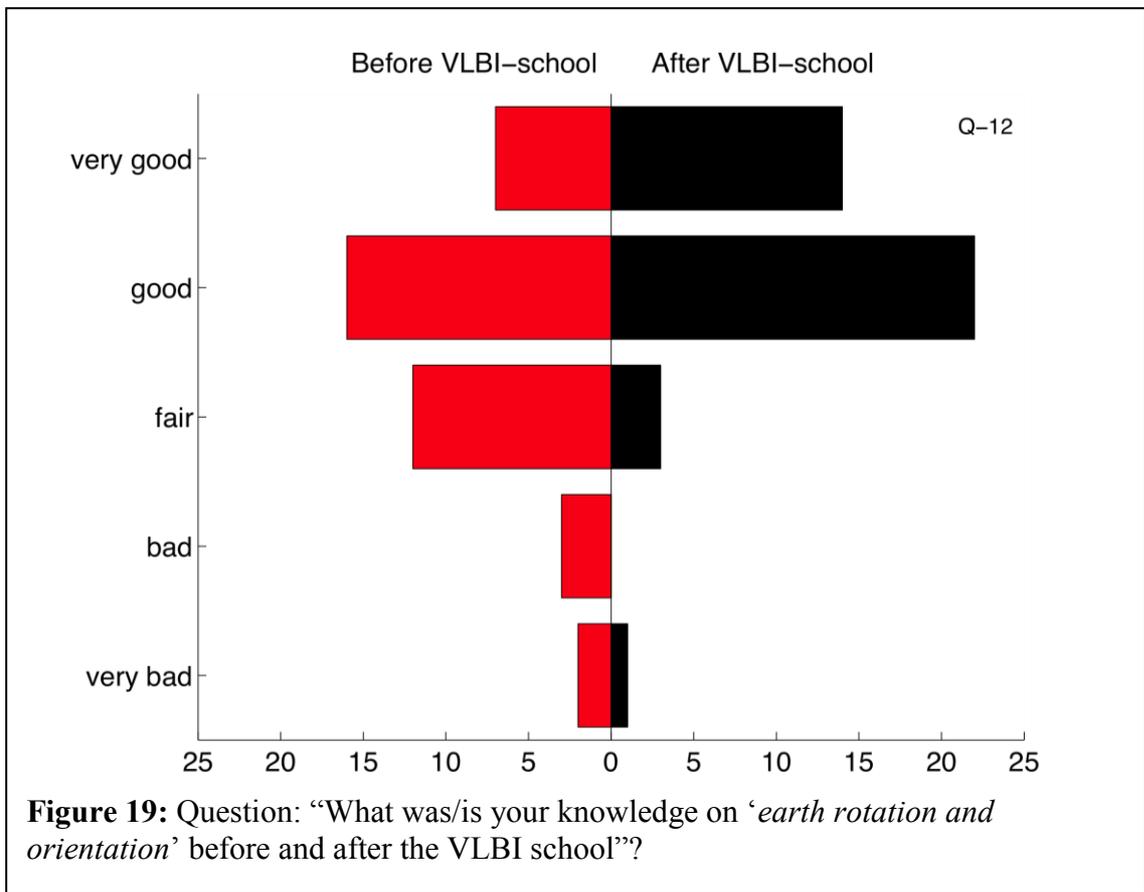
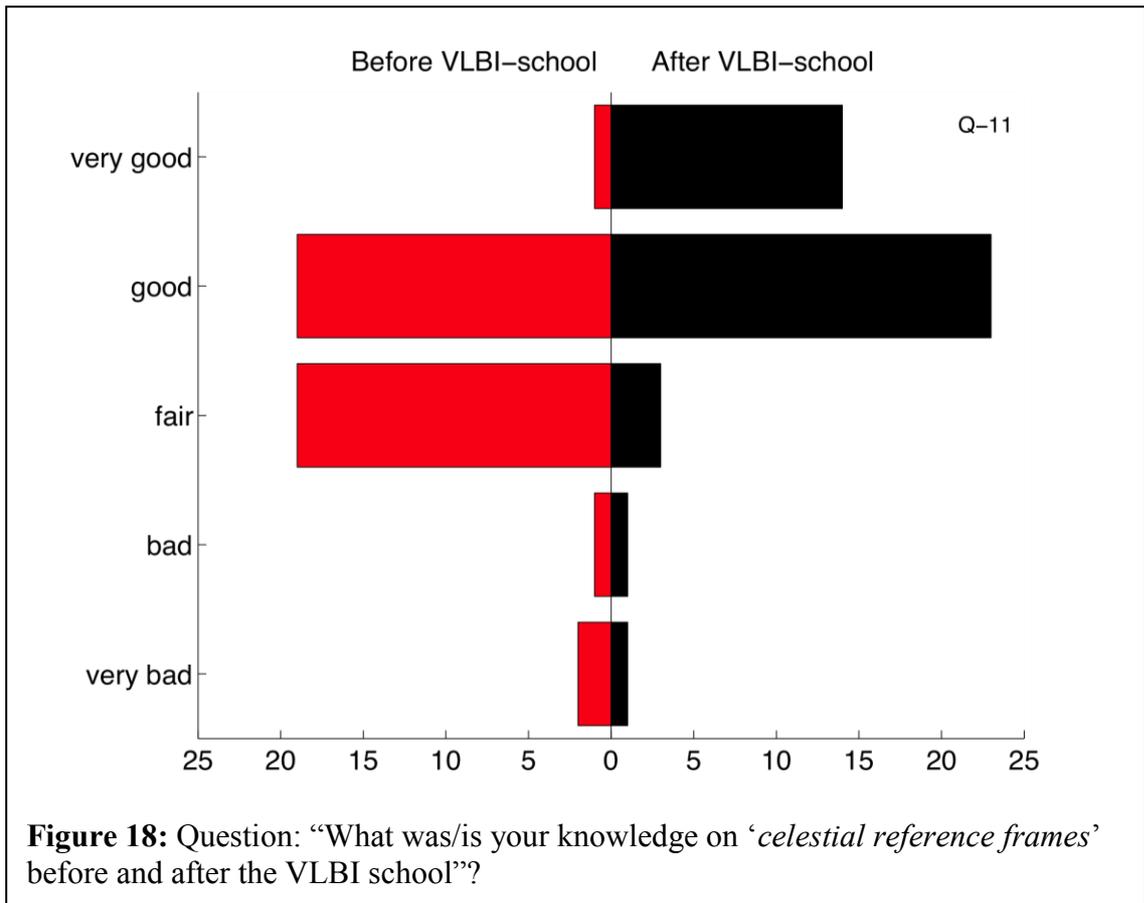


Figure 17: Question: “What was/is your knowledge on ‘*radio sources*’ before and after the VLBI school?”



The evaluation shows that the three exercises were appreciated by the students and evaluated as ‘good’ to ‘very good’. Several participants answered in the free-text comments of the evaluation questionnaire that the practical exercises were the best part of the VLBI Training School. There was however also some concern that the time was too short to work on some of the exercises. Some participants thought that there should be even more exercises during potential future VLBI Training Schools.

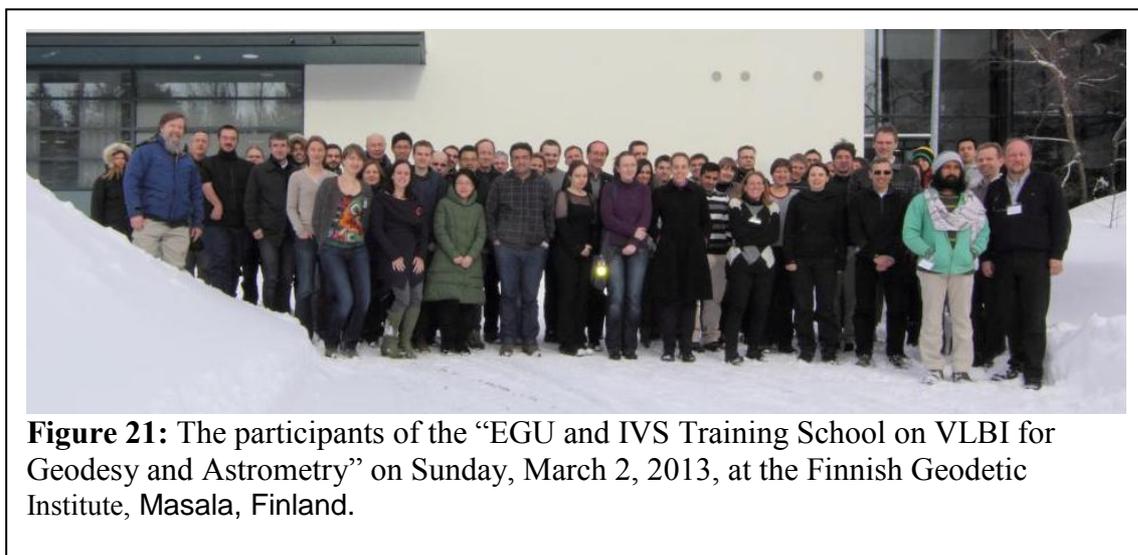
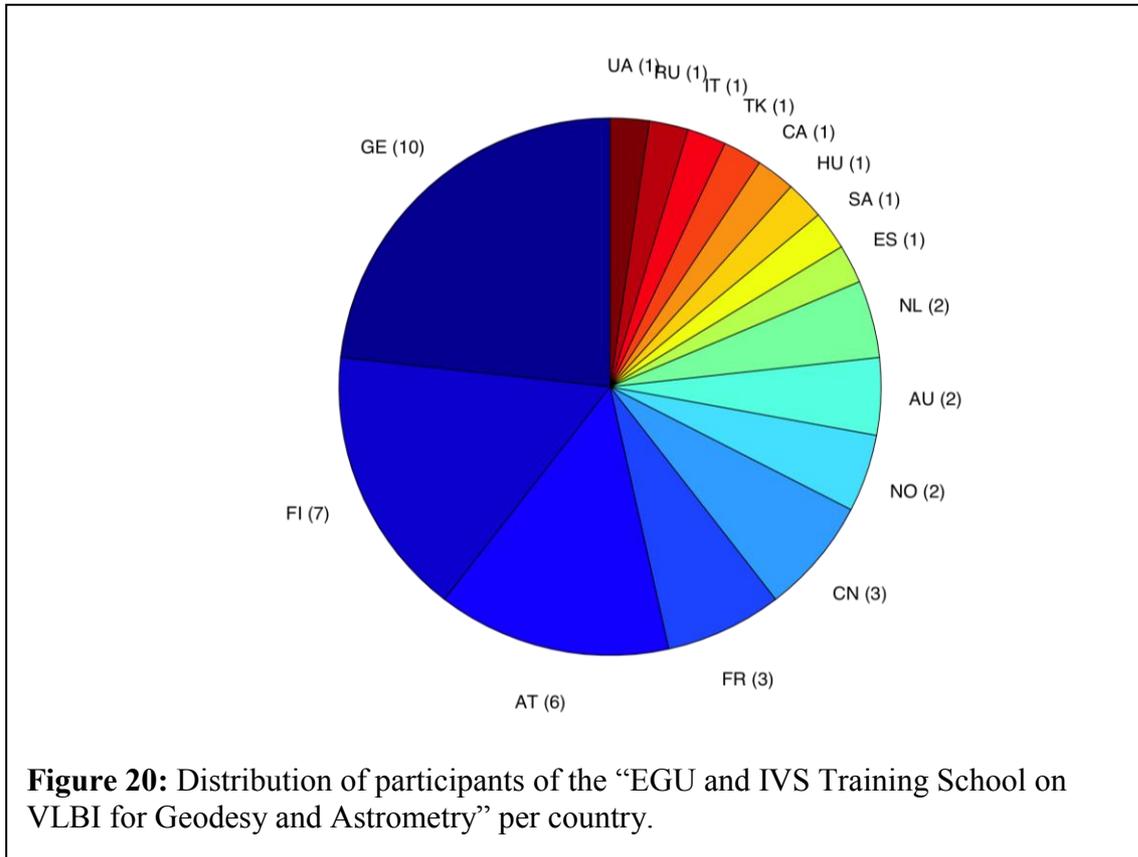
The evaluation also shows that the personal impression of the participants is that they know more on the particular topics after the VLBI Training School than before. More people feel that they have ‘good’ and ‘very good’ knowledge after the VLBI Training School. So there appears to be again in knowledge and the goal to provide education and training has been achieved to a large extend. Many of the free-text comments on the lectures said that the lectures gave a very good overview of all features of VLBI.

The lecture slides are available at the webpages of the European VLBI Group for Geodesy and Astrometry (EVGA, www.evga.org/material_vlbi_school_2013.html). The intention is that they can be used as a basis for teaching at educational institutes.

The IVS Directing Board had a directing board meeting in Metsähovi on March 8, after the “EGU and IVS Training School on VLBI for Geodesy and Astrometry”. The IVS DB regarded that the “EGU and IVS Training School on VLBI for Geodesy and Astrometry” held in Espoo and Masala was a success. For the next IVS DB in the fall of 2013 a final report of the IVS WG 6 needs to be prepared, so that IVS WG 6 can be closed down. However, then an IVS Committee on Training and Education shall be established, with the task to continue the work started by IVS WG 6. It is anticipated to organize VLBI Training Schools on a regular basis, preferably every third year alternating in connection with the IVS General Meetings and the European VLBI meetings.

D) ATTENDANCE LIST

There were 43 participants in the VLBI Training School coming from 16 different countries. The countries with more than 1 participant were Germany (10), Finland (7), Austria (6), France (3), China (3), Norway (2), Australia (2) and the Netherlands (2). The distribution of the countries is presented in Figure 20. A group photo taken on the second day of the VLBI Training School when lectures and exercise were held at the headquarters of the Finnish Geodetic Institute (FGI) in Masala, is shown in Figure 21.



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